Radiation Belt Precipitation and the Atmospheric Impact

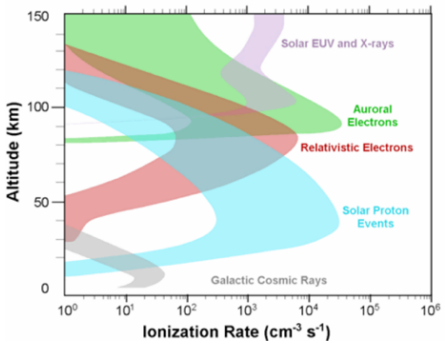
Chia-Lin Huang[1], Harlan E. Spence[1], Katharine Duderstadt[1], Sonya Smith[1], Alex Boyd[2], Geoff Reeves[2], J Bernard Blake[3], J. F. Fennell[3], Seth Claudepierre[3], Drew Turner[3], Alex Crew[4], David M Klumpar[5], Mykhaylo Shumko[5], Arlo Johnson[5] and John Sample[5]

[1]*University of New Hampshire,* [2]*Los Alamos National Laboratory,* [3]*Aerospace Corporation,* [4]*Applied Physics Laboratory,* [5]*Montana State University*

1. Motivation and Goal

Motivation: Do radiation belt electrons provide a missing source of HO_x and NO_x with implications for O_3 reduction in the upper and middle atmosphere? (*Randall et al.*, 2015)

Goal: Estimate the precipitation flux and energy spectrum of radiation belt electrons and quantify the contribution of electron precipitation to atmospheric chemistry



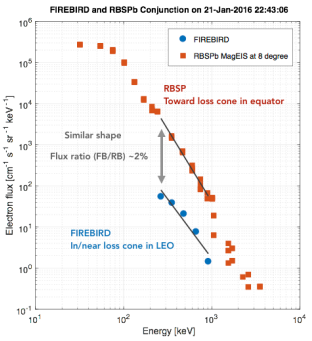
Radiation belt electron impact not well-known

2. Flux Ratio of Precipitated and Trapped Electrons

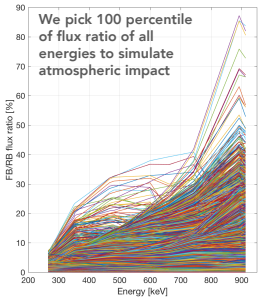
- NSF FIREBIRD: High time resolution at critical energies in the loss cone at low Earth orbit
- NASA Van Allen Probes (RBSP): Continuous coverage in the radiation belt near equator

Compare FIREBIRD & Van Allen Probes at Conjunctions

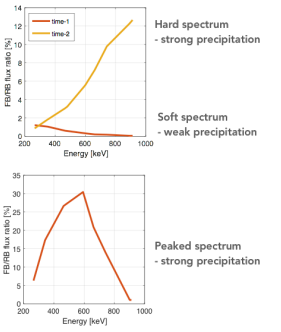
- To quantify poorly known global radiation belt precipitation
- 35 quality conjunctions from 14 FIREBIRD campaigns
- Calculate flux ratio between precipitated and trapped electrons
- Scaled Van Allen Probes data to provide more global, more continuous time series of precipitation



Flux ratios from 35 FB-RB conjunctions



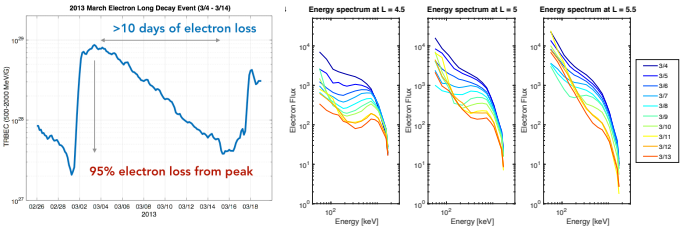
Flux ratios as function of Energy



3. Selecting Radiation Belt Electron Loss Event

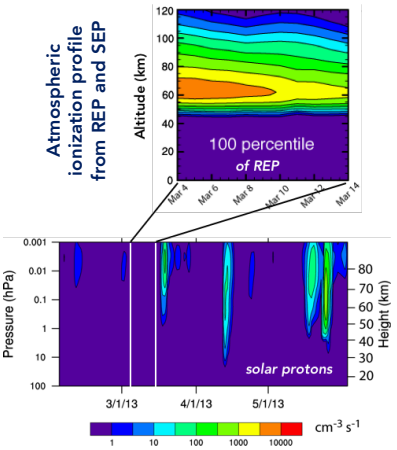
Total radiation belt electron content: (TRBEC) - a simple and global index to represent RB electrons by integrating the phase space density data from RBSP-ECT MagEIS data

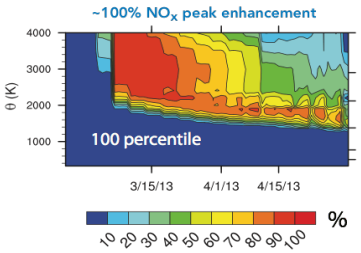
2013 March 3- 14 event: long-quiet decay without or little magnetopause shadowing loss

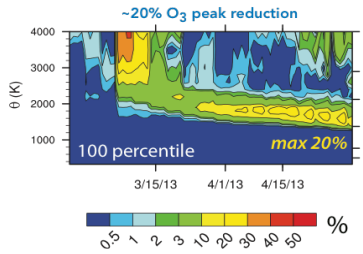


4. Atmospheric Impact from RB Electron Precipitation

- Whole Atmosphere Community Climate Model (WACCM)
- Ion pair production rate: comparable to solar protons near 70 km
- Northern hemisphere polar vortex-averaged NO_x enhancement x(~100%) and O_3 reduction (~20%) compared to simulations without radiation belt electron input







5. Summary

- We estimated radiation belt electron precipitation flux and energy spectrum using FIREBIRD and Van Allen Probes data
- We quantified the contribution of electron precipitation to atmospheric chemistry: 20% reduction of O_3 in stratosphere from moderate RB electron precipitation

Contact: Chia-Lin.Huang@unh.edu

University of New Hampshire

Van Allen Probes

FIREBIRD